Statistical Analysis of CO_2 Exposed Wells to Predict Long Term Leakage through the Development of an Integrated Neural-Genetic Algorithm

Project DE FE0009284

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Developing the Technologies and
Infrastructure for CCS

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Presentation Outline

- Benefit to DOE Program
- Project Overview
- Technical Status
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- Summary

Benefit to DOE Program

The project conducts research under DOE's *Fossil Energy Research and Development* Area of Interest 1, Studies of Existing Wellbores Exposed to CO_2.

The project will perform analysis of available industry and regulatory data to assess risks of well failure by various factors such as age of construction, region, construction materials, incident reports, logging and Mechanical Integrity Testing.

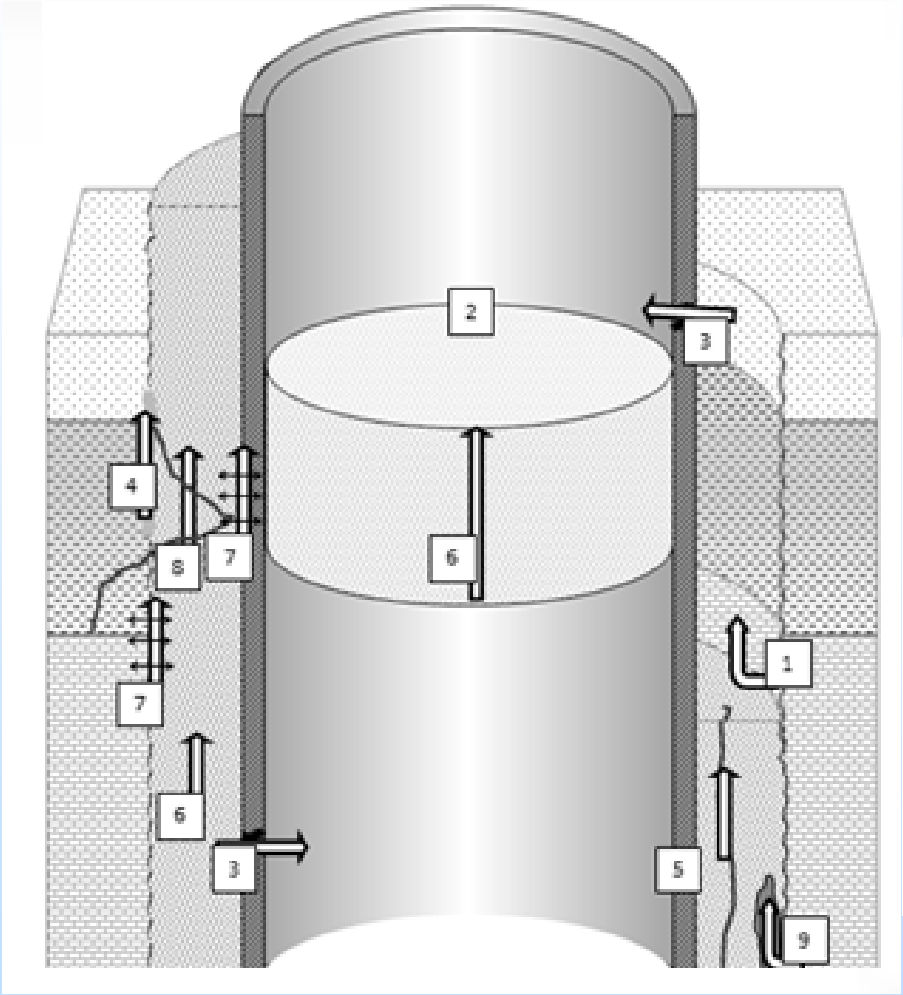
The computer model developed in this project will contribute to the DOE programs' effort of ensuring 99% CO_2 storage permanence in the injection zone(s) for 1000 years and support the development of Best Practices Manual.

Project Overview

The overall objective of this project is the development of a novel computer model for predicting long-term leakage risks of wells exposed to CO_2.

The final goal is to deliver DOE and public a useful tool for evaluating the risk of long-term leakage of wells in future CO_2 sequestration projects.

Technical Status



Potential CO2 leakage paths (modified from Celia, 2004)

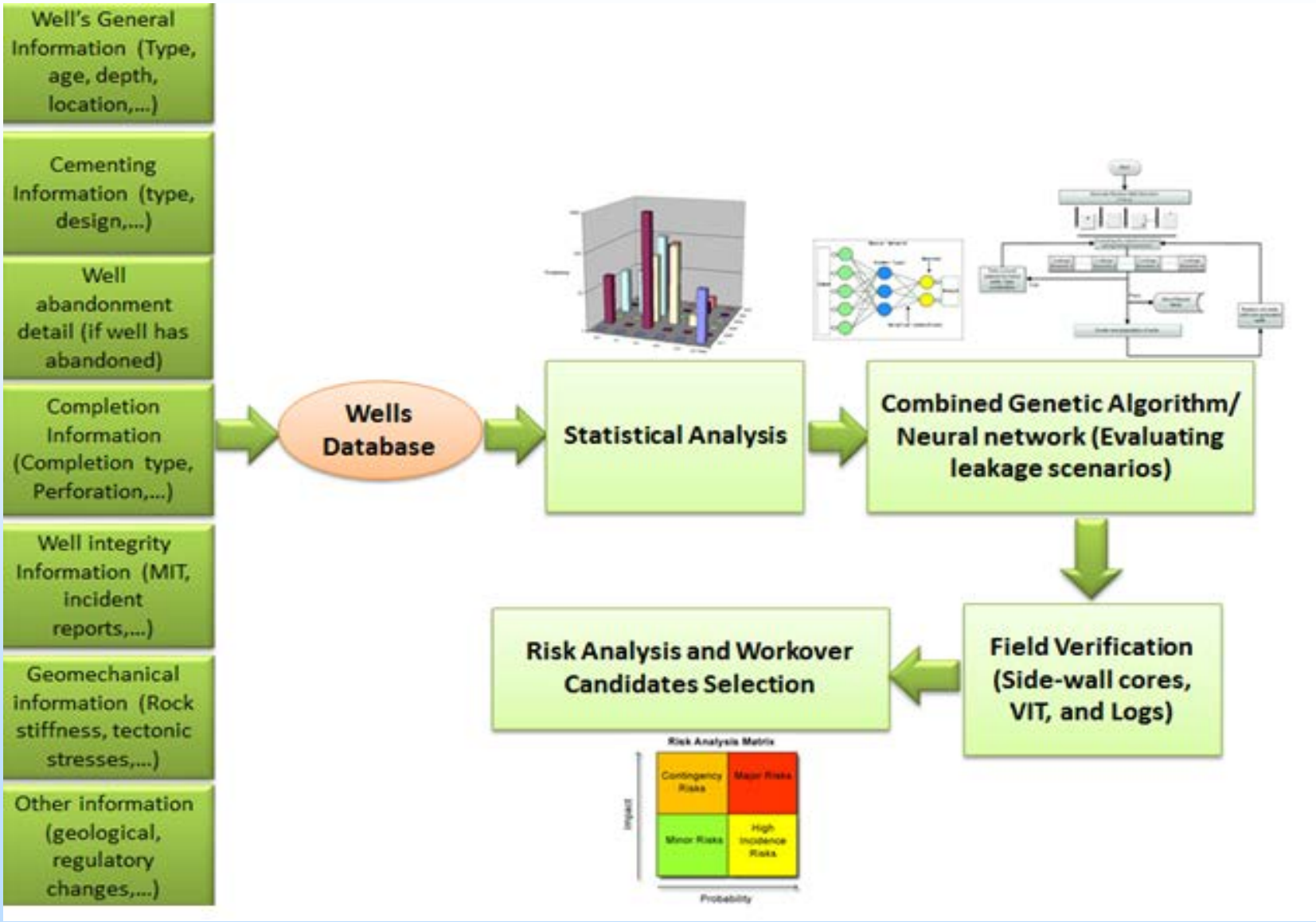
PRIMARY

1. Incomplete annular cementing job, doesn't reach seal layer
2. Lack of cement plug or permanent packer
3. Failure of the casing by burst or collapse
4. Poor Bonding caused by Mudcake
5. Channeling in the cement
6. Primary permeability in Cement Sheath or Cement plug

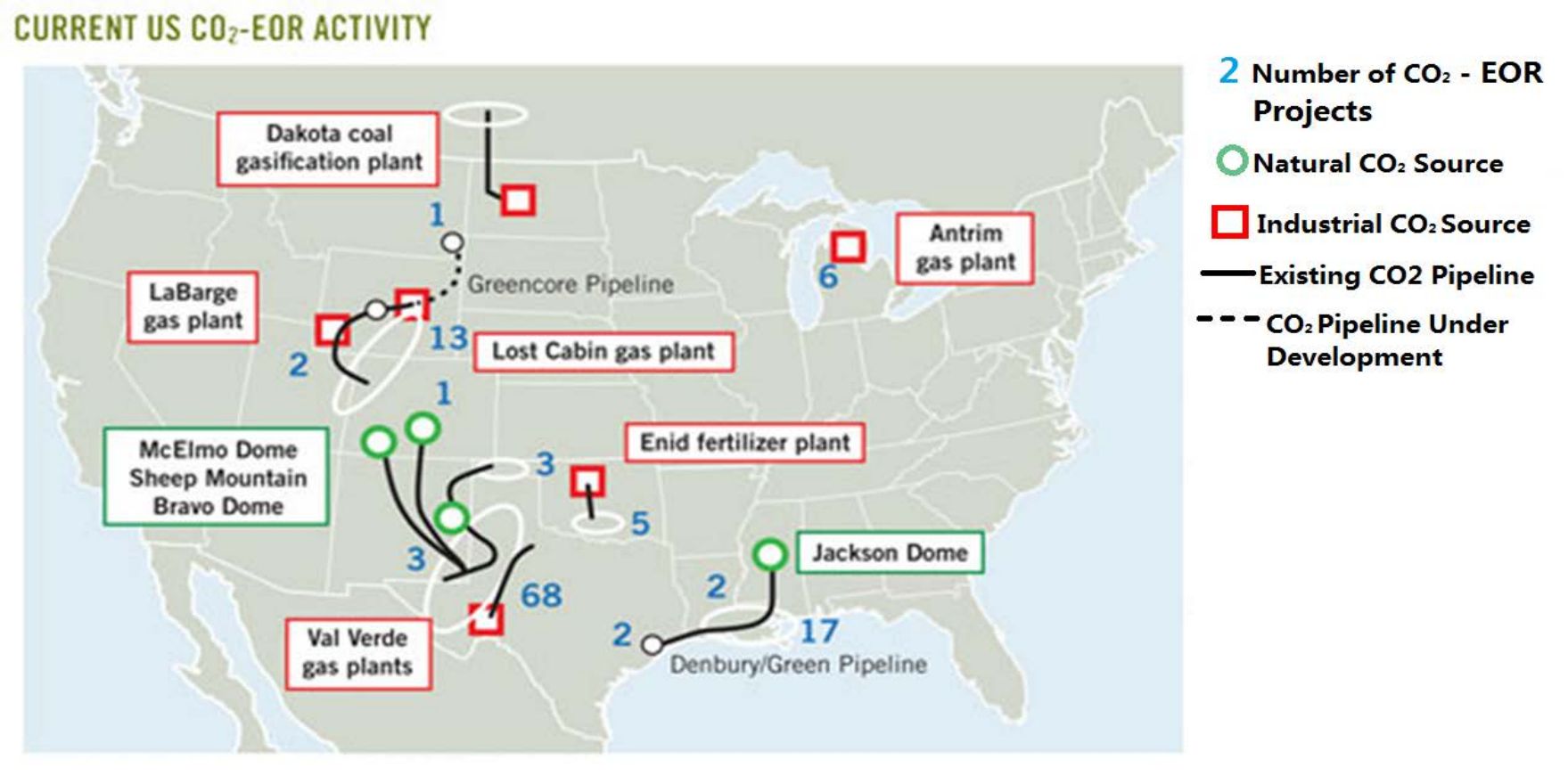
SECONDARY

7. De-bonding due to tensile stress on Casing-cement-formation boundaries
8. Fractures in cement and formation
9. Chemical dissolution and carbonation of cement

Accomplishments to Date



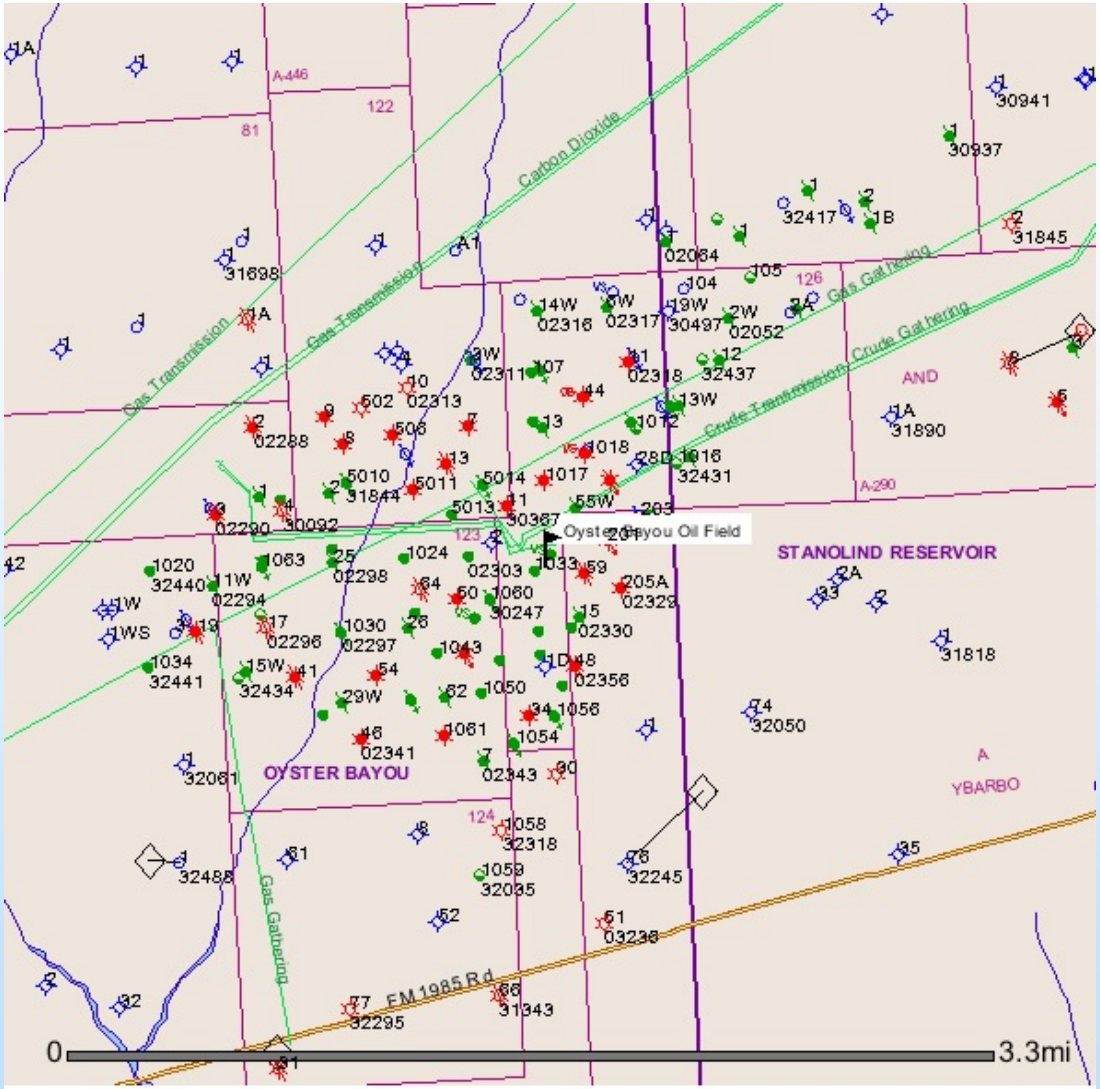
US CO2-EOR Projects



The number of CO_2-EOR projects has increased to 123 in 2012.

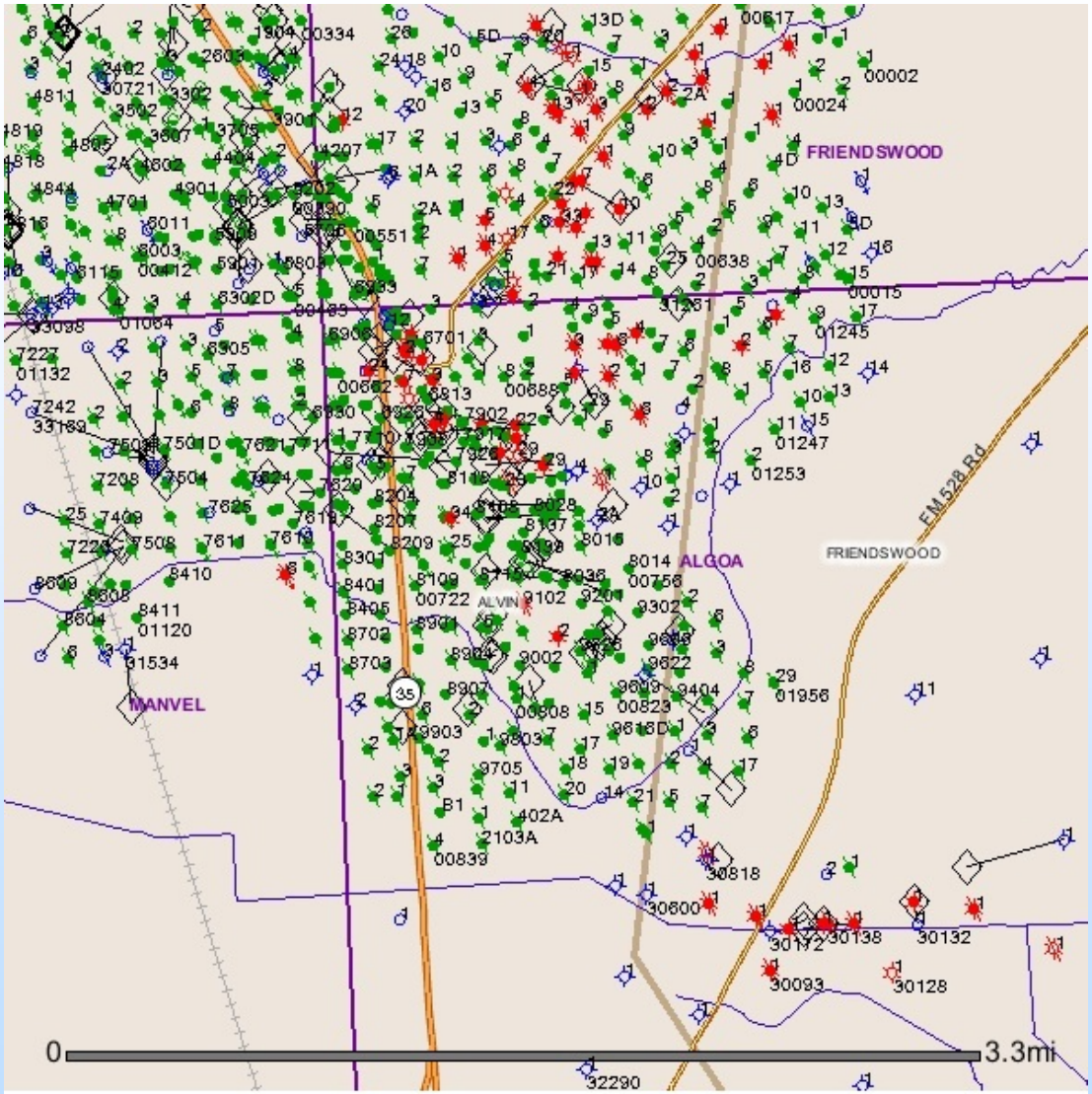
Focus of This Project

- **Oyster Bayou oil field in Chambers County**
- **It is in a deep (8,500 ft) reservoir with light 39^{o} gravity oil.**



Oyster Bayou Oil Field

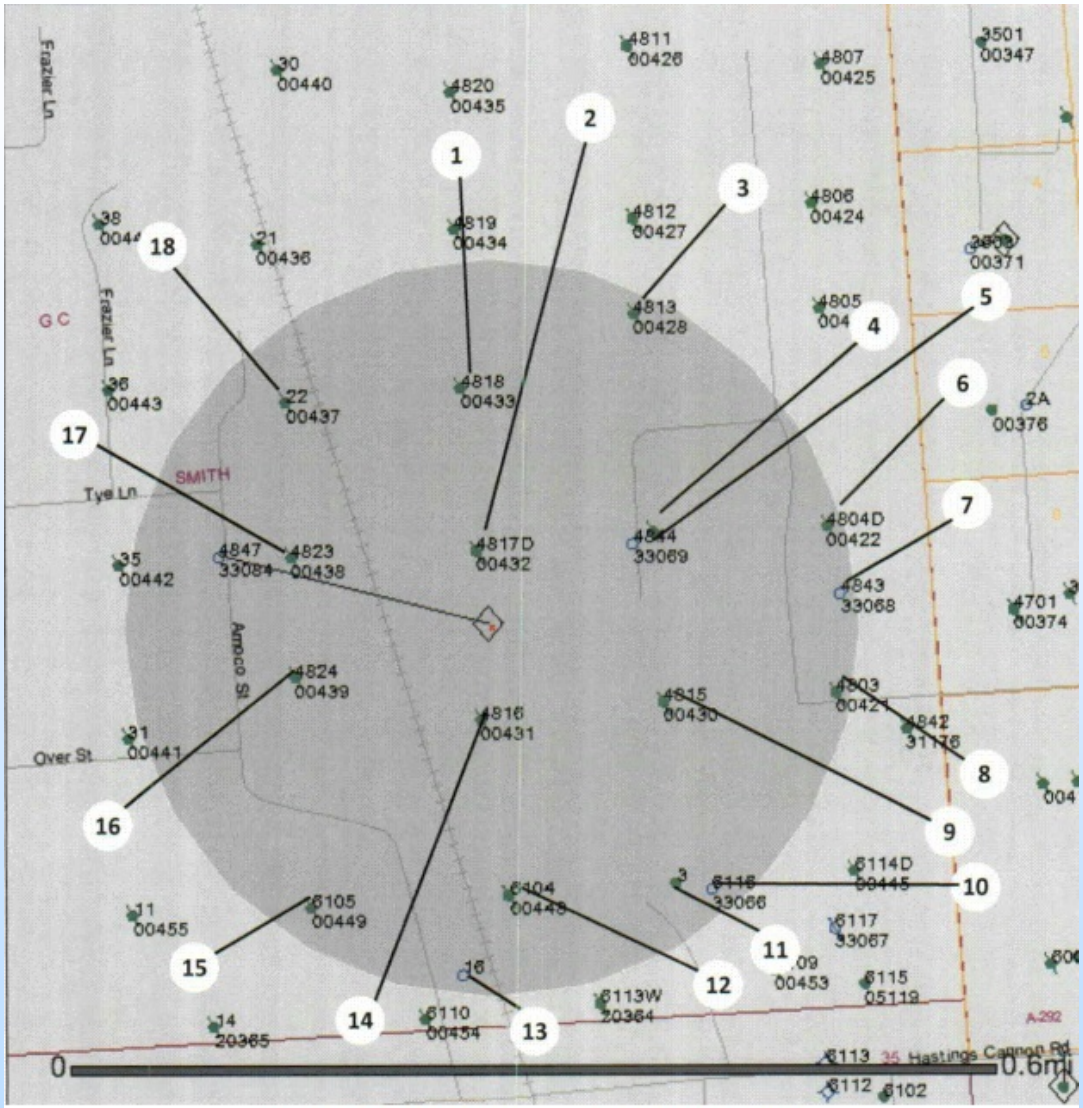
- **The Oyster Bayou Oil Field (Frio sandstone) miscible CO_2 flood covers 3,900 acres.**
- **It is in a deep (8,500 ft) reservoir with light 39° gravity oil.**



West Hastings Oil Field

- Denbury started injecting CO_2 for enhancing oil production in December 2010.
- In January, 2012, Denbury commenced tertiary oil production, the largest field flooded with CO_2 to-date.
- The CO_2 flood is in a moderate depth (5,700 ft) formation with 31° gravity oil.

Data Mining Area



1/4 Mile Radius of Well 4847

- CO2 injection well information, including well general information, completion, cementing, well integrity information, etc.
- Plugged wells in the ¼ mile radius of CO2 injection well, and get these wells' information including well general information, completion, cementing, plugged information, well integrity information, etc.

Data Mining Result

Oil Field	CO_2 Injection Wells	Plugged Wells	Subtotal
West Hastings	25	55	80
Oyster Bayou	56	372	428
TOTAL	81	427	508

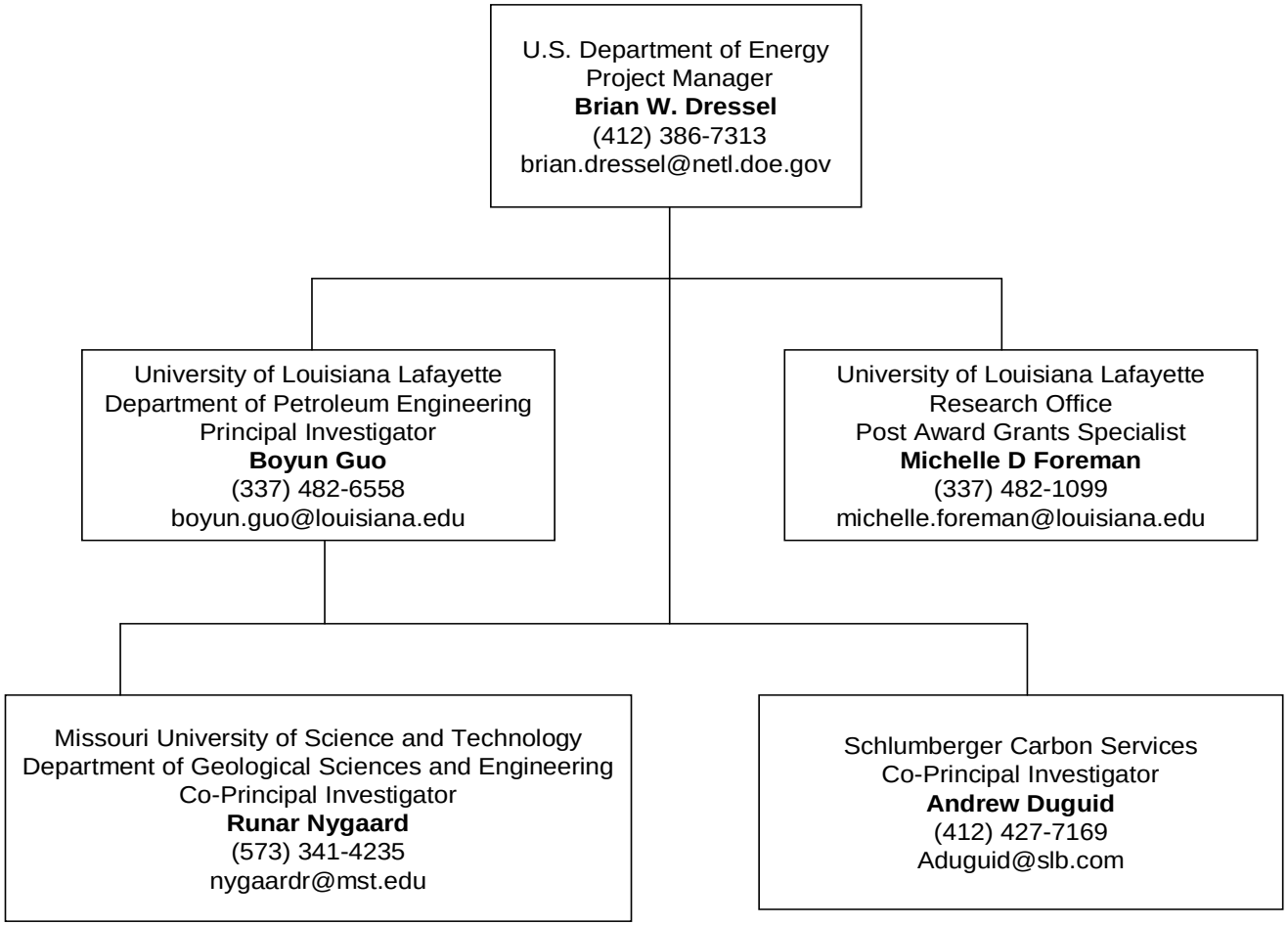
Summary

- Data have been collected from 508 CO2-exposed Wells in 2 GoM oil fields.
- Data set for some wells are not complete.
- Future effort will focus on collecting more data from RCT and private sectors.

Appendix

- Organization Chart
- Gantt Chart
- Bibliography

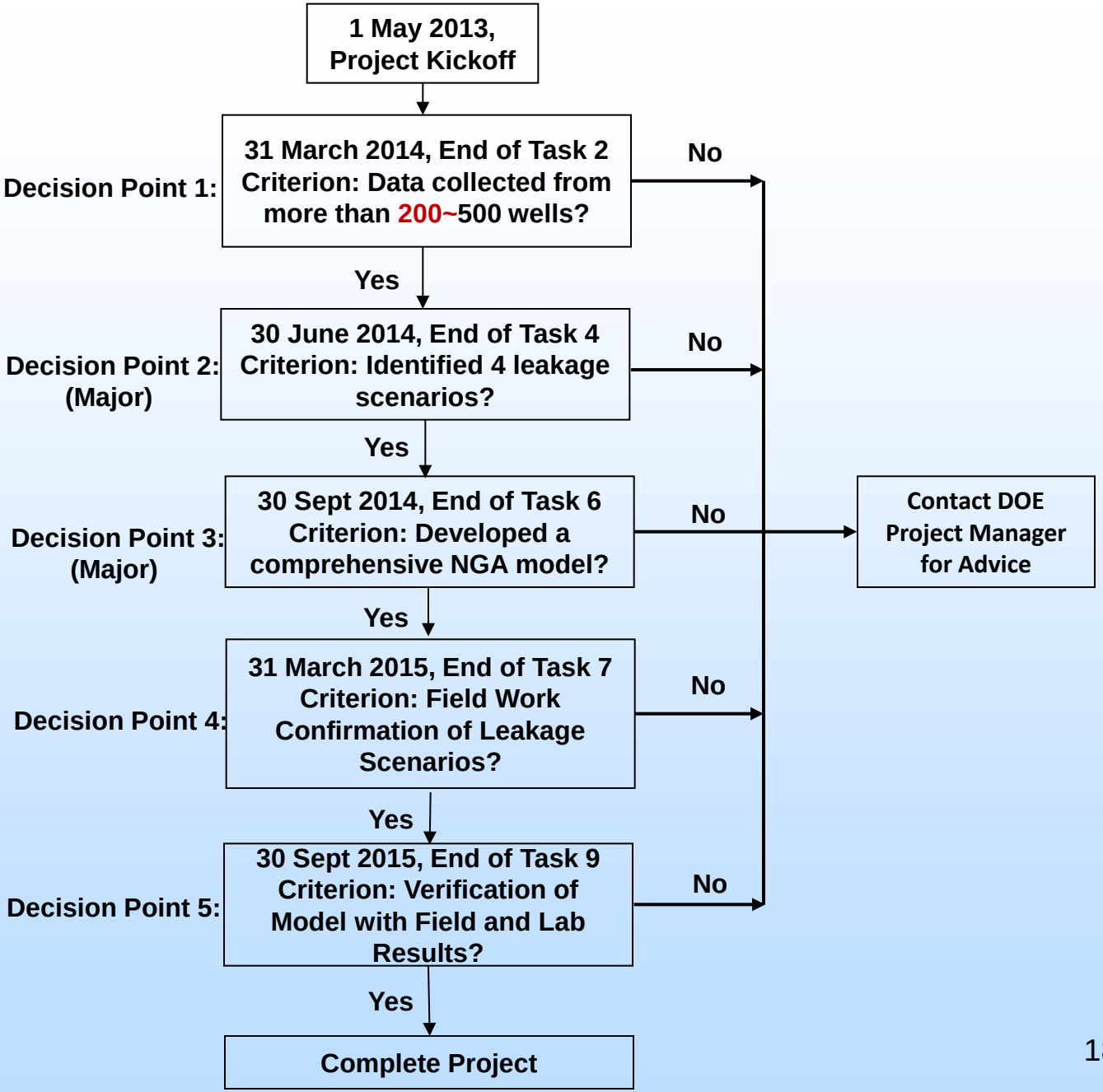
Organization Chart



Gantt Chart

Year	2013				2014				2015				Team Member and Role
Quarter	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	
Task 1: Project Management and Planning	←	—	—	—	—	—	—	—	—	—	—	→	Guo (PI), Nygaard (Co-PI), Duguid (Co-PI)
Task 2: Data Mining		←	—	—	—	→							Guo (PI), Nygaard (Co-PI), Duguid (Co-PI)
Task 3: Statistical Analysis of Database					←	↔	→						Nygaard (Co-PI)
Task 4: Developing Leakage Scenarios					←	↔	→						Guo (PI), Nygaard (Co-PI), Duguid (Co-PI)
Task 5: Constructing Preliminary Neural-Genetic Algorithm						←	↔	→					Guo (PI), Sedaghat and Li

Year	2013				2014				2015				Team Member and Role
Quarter	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	
Task 6: Constructing Comprehensive Neural-Genetic Algorithm								↔					Guo (PI), Sedaghat and Li
Task 7: Field Work Confirmation of Leakage Scenarios									↔				Duguid (Co-PI)
Task 8: Field Sample Analysis										↔	↔	↔	Guo (PI), Sedaghat and Li
Task 9: Verification of Model with Field and Lab Results											↔	↔	Guo (PI), Sedaghat and Li
Task 10: Risk Study, Mitigation Actions, and Standard Recommendations												↔	Guo (PI), Nygaard (Co-PI), Duguid (Co-PI)


1 May 2013, Project Kickoff
Decision Point 1:
31 March 2014, End of Task 2 Criterion: Data collected from more than 200~500 wells?
No
Yes
Decision Point 2: (Major)
30 June 2014, End of Task 4 Criterion: Identified 4 leakage scenarios?
No
Yes
Decision Point 3: (Major)
30 Sept 2014, End of Task 6 Criterion: Developed a comprehensive NGA model?
No
Contact DOE Project Manager for Advice
Yes
Decision Point 4:
31 March 2015, End of Task 7 Criterion: Field Work Confirmation of Leakage Scenarios?
No
Yes
Decision Point 5:
30 Sept 2015, End of Task 9 Criterion: Verification of Model with Field and Lab Results?
No
Yes
Complete Project

Bibliography